A MODIFIED METHOD OF IMPLANTING MONOPOLAR CORTICAL ELECTRODES IN LARGE LABORATORY ANIMALS

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SUMMARY PAGE

THE PROBLEM

To modify the electrode implantation technique developed for recording visual evoked responses from rats, so that it can be used with larger animals.

FINDINGS

The general technique was successfully adapted for use with cats, providing an electrode assembly as inexpensive, durable, and reliable as that previously developed for the rat.

APPLICATION

A very simple technique is now available for chronically implanting monopolar brain electrodes in laboratory animals of all sizes. Because of its simplicity, as well as generality and inexpense, laboratories interested in studying neural effects of hazardous environments (such as high compression atmosphere) should have little trouble adapting this technique to their research program.

ADMINISTRATIVE INFORMATION

This investigation was conducted as part of Bureau of Medicine and Surgery Research Work Unit MF51.524.004-9015DA5G. The present report is Number 11 on this work unit. It was submitted for review on 2 August 1973, approved for publication on 30 August 1973 and designated as NavSubMedRschLab Report No. 750.

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ABSTRACT

A simple yet reliable method for implanting rats with durable monopolar cortical electrodes, using miniature self-tapping screws, was recently reported. The present paper describes the details of modifications in that method to adapt its use to larger laboratory animals. Four adult cats were implanted using the modified technique, and evaluation of their records demonstrated highly consistent VERs over extended periods of time, and direct comparison with conventional wire electrodes revealed no essential differences.

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INTRODUCTION

In a recent paper,[1] a simple technique was described for chronically implanting monopolar cortical electrodes in the rat. This technique utilizes commercially available miniature self-tapping stainless steel screws which are threaded into the rat's skull, serving a dual role as electrodes and assembly anchors. Teflon coated stainless steel wire is simply fastened to the screw shaft at one end by wrapping the wire, and at the other end by crimping it to miniature pins which insert into a small Amphenol strip connector. The strip connector and screws are then embedded in a mound of dental acrylic. The resultant assembly has proven to be extremely durable, outlasting the lives of all but a few of the implanted rats, and has provided reliable brain recordings, both within and between rats. It was suggested that this technique might be successfully adapted for use in larger animals. The present paper describes an extension of this technique to the cat, and the results of evaluations that were made to test its effectiveness.

METHOD

Four adult cats were used as subjects, with sterile surgical procedures followed. Each cat was mounted in a Kopf stereotaxic instrument and the skull exposed via a single longitudinal incision along the mid-line.

The materials used for the electrode assembly are shown in Fig. 1. The screws selected for the electrodes were # 00 x 1/8" (Fig. 1a). The active electrode was positioned over area 17, with the reference placed over the ipsilateral nasal sinus and the ground over the contralateral nasal sinus. Lead holes for the self-tapping screws were bored using a dental drill, and a # 702 Ransom & Randolph, New Cutwell dental bur. This bur size provides the exact diameter required for optimal use of the self-tapping feature of this screw. It was also found that if a small triangular trephine was used to make an initial hole, the lead hole could then be enlarged with the # 702 dental bur using a simple, hand pin vise. Thus, a dental drill is not an essential tool for this procedure.

A nine conductor Amphenol "Tiny Tim" connector served as the assembly plug (see Fig. 1b). The flange protruding from each end of this connector provides an excellent means of securing the plug to the skull. This is accomplished with two #2 x 1/4" self-tapping screws, which fit perfectly into the hole of each flange. The lead holes for these screws were drilled with a #4 White Revelation dental bur. A small amount of dental acrylic is placed under the connector before the screws are completely tightened, so that a firmer base is provided and no air pockets are formed after the incision is closed. Once again, the

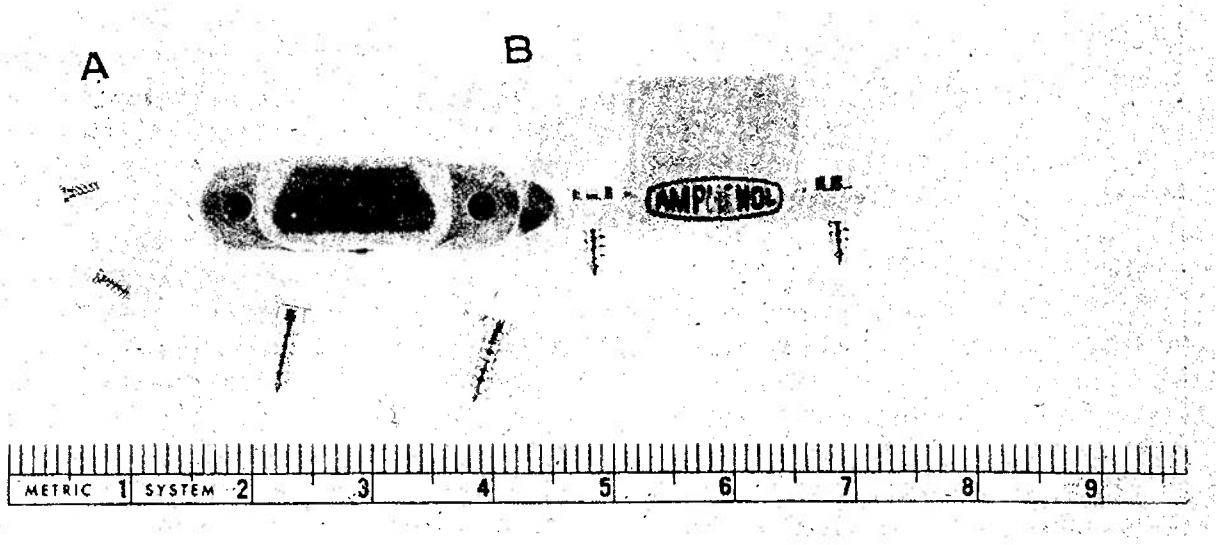

Fig. 1. Basic materials used for chronic cat implants: a) self-tapping screw electrodes, b) assembly socket and self-tapping anchor screws. The numbered demarcations on the scale refer to cm gradations.

self-tapping feature of this screw provides an unusually easy method of making strong attachments to the skull.

It was also found that standard subcortical depth electrodes could be secured in place by mounting a single slender self-tapping screw (# 00 x 1/4") in the vicinity of the electrodes to serve as a common anchor. The shaft and head of this screw and the protruding ends of the depth electrodes are then cemented together with dental acrylic, serving to fix the depth electrode firmly in place. After all electrode screws are tightened, dental acrylic is applied over all screw heads, as well as the plug flanges. This provides additional stability while the bone is growing around the screw threads, and also serves to insulate the heads of screw-electrodes from muscle and skin potentials.

Finally, in order to compare the VERs obtained from these screw-electrodes with the more conventional wire or needle electrodes, each cat was also implanted with a .25-mm diameter stainless steel wire electrode having a 1-mm recording tip. This electrode was placed over the dura in area 17 within 4 mm of the cortical screw electrode, and recordings were made from these two electrodes simultaneously.

After a minimum two-week recovery period, each cat was tested to determine the reliability of the VERs obtained from the electrodes, and the comparability of the wire and screw electrodes. VERs were obtained by first placing each cat in a specially designed head-holder, body-restrainer to limit excessive body movement and changes in head orientation.[2] The

restrained cat was then placed directly in front of a white hemisphere and a Grass photo stimulator was positioned directly behind the cat. The visual stimuli were produced by projecting the flashes from the photo stimulator onto the hemisphere at a rate of 0.5 Hertz, and averaging the EEG time-locked to each of the 50 flashes.

RESULTS AND DISCUSSION

Samples of the VERs obtained from the cortical screw electrodes are shown in Fig. 2. Samples a and b were taken approximately one hour apart on the same day, while sample c was recorded several months later. As can be seen, the characteristic waveform varied little from recording session to session for each cat. Furthermore, as shown in Fig. 3, there exists very little difference in the VERs obtained with the screw or the more conventional wire electrodes. The small differences that do exist between records can easily be accounted for by the 4-mm difference in cortical placement between the two electrodes.

This assembly has also proven to be quite durable. Surgery was performed several months prior to this writing, and all assemblies are still intact. In fact, because the electrodes and anchors are actually threaded into the 3-mm skull, bone-healing around the screw threads can now be expected to make the assembly stronger as time passes.

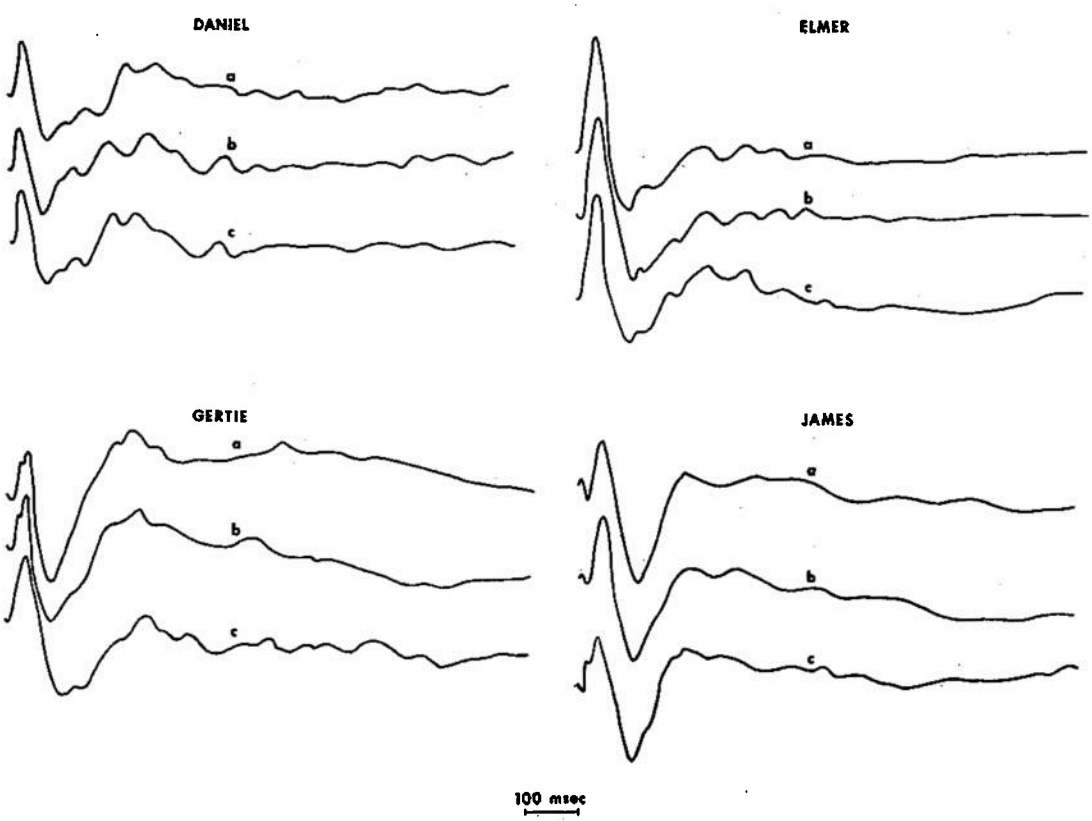

Fig. 2. Comparisons of VERs: Traces a and b were taken approximately one hour apart and trace c was recorded months later.

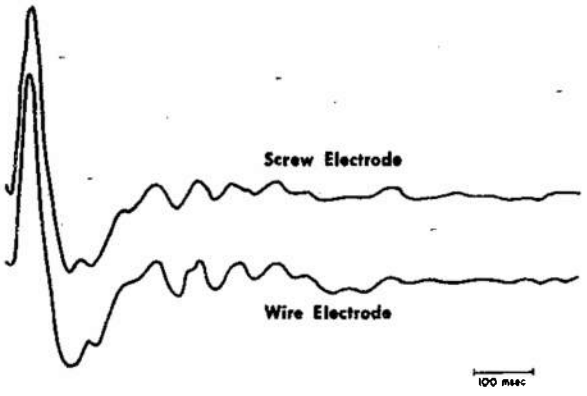

Fig. 3. Comparison of VERs from visual area 17, recorded with screw and conventional wire electrodes.

Finally, the assemblies and subsequent recordings obtained from this technique have been applied to current programs investing neural effects of nitrogen narcosis, and the initial results have been quite successful.[3] Additionally, this technique is currently being employed to implant electrodes in several Rhesus monkeys, and is also to be used in future hyperbaric research.

In summary, the technique described in this and the previous paper[1] provides a very convenient method for implanting laboratory animals of all sizes. In addition to being extremely easy to perform, the procedure provides a durable, inexpensive assembly and allows the recording of VERs which are highly consistent and perfectly comparable with those obtained from conventional wire monopolar electrodes.

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